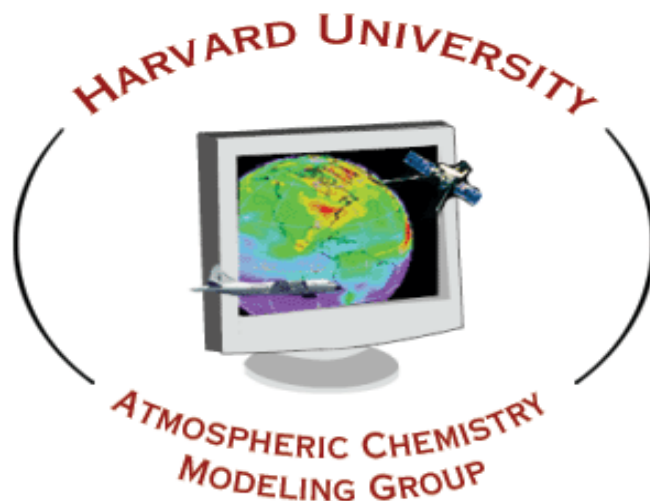
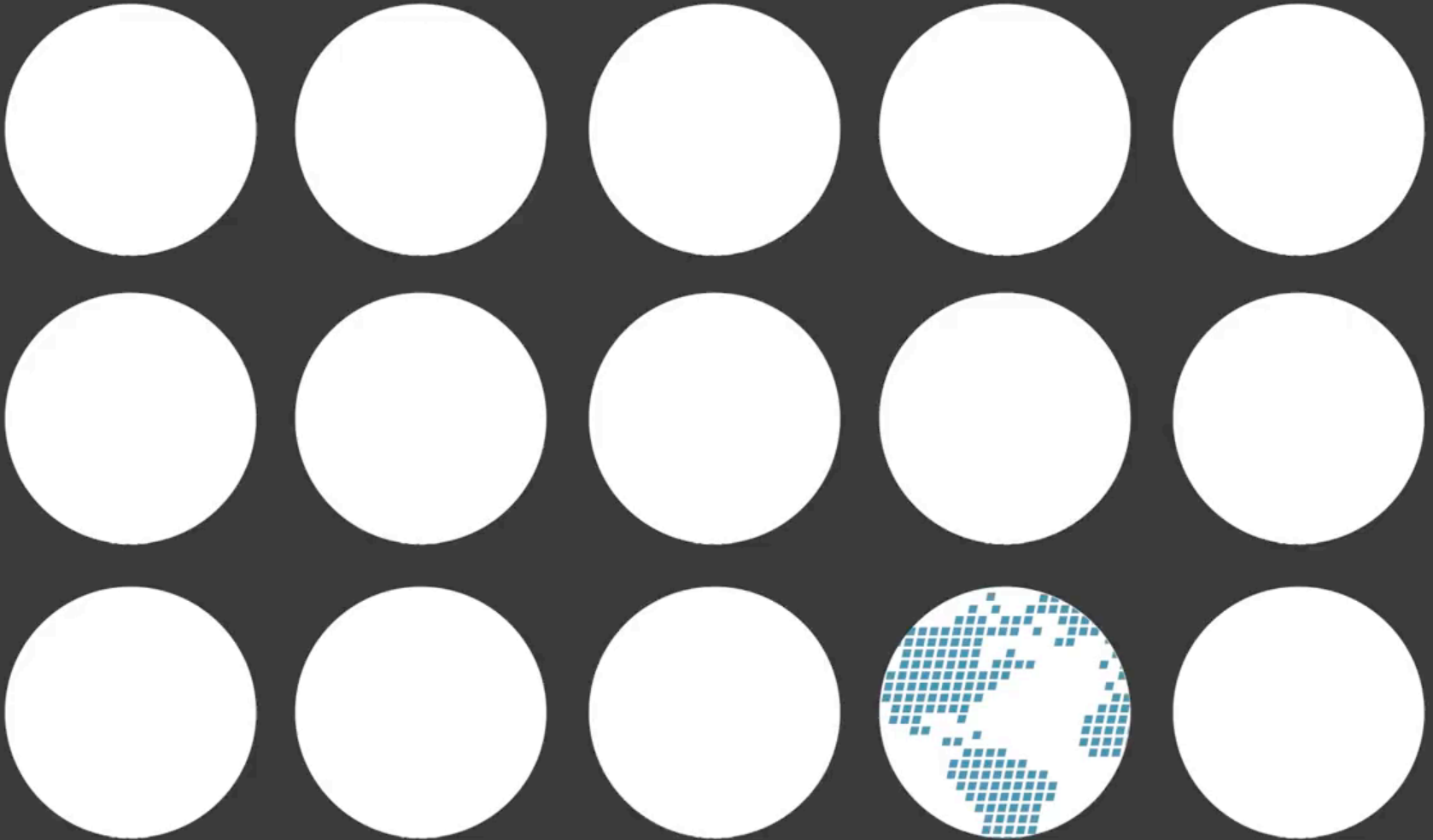


How Aura transformed air quality research with a look forward to TROPOMI and geostationary satellites

Daniel Jacob

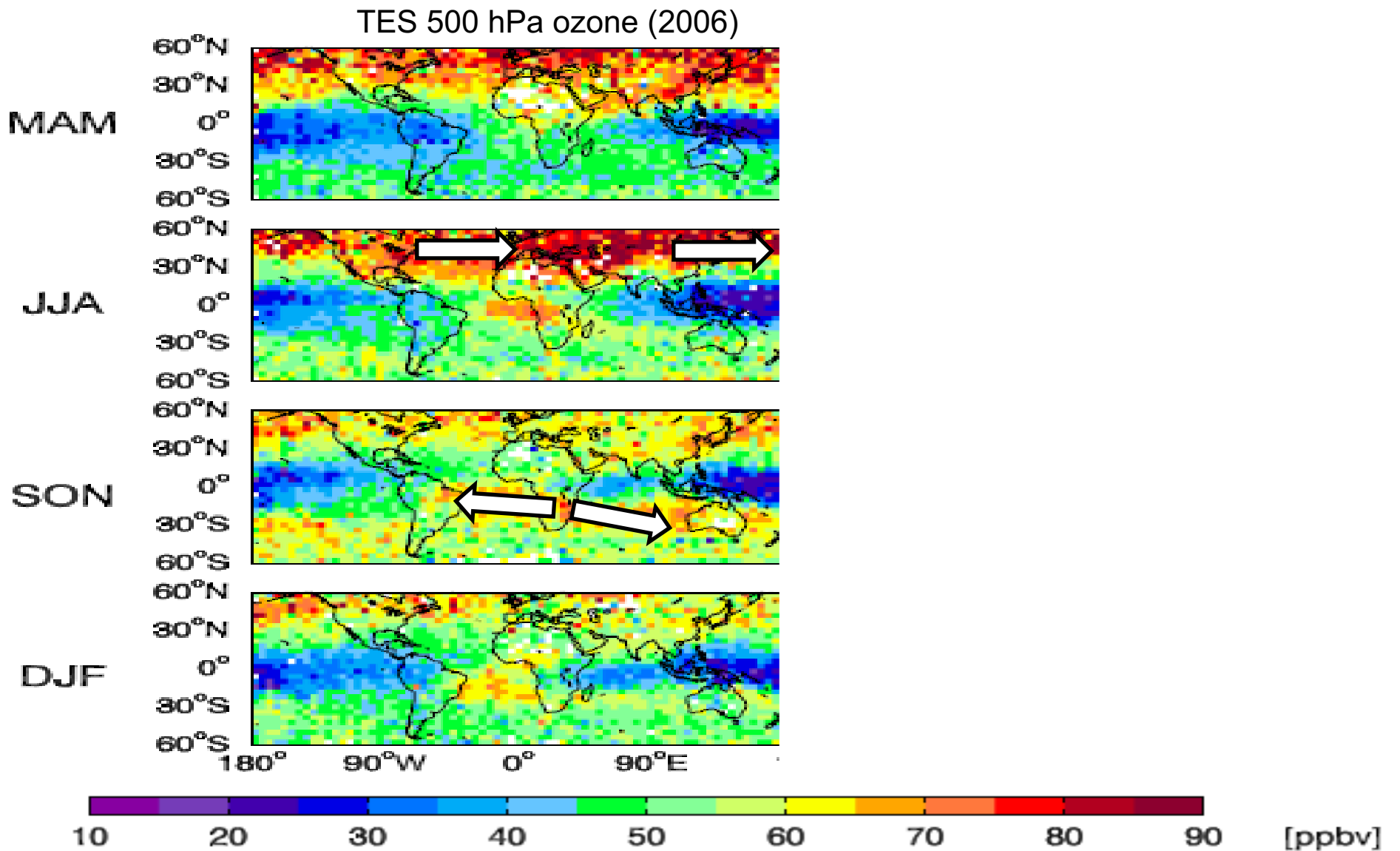


I couldn't say it better...



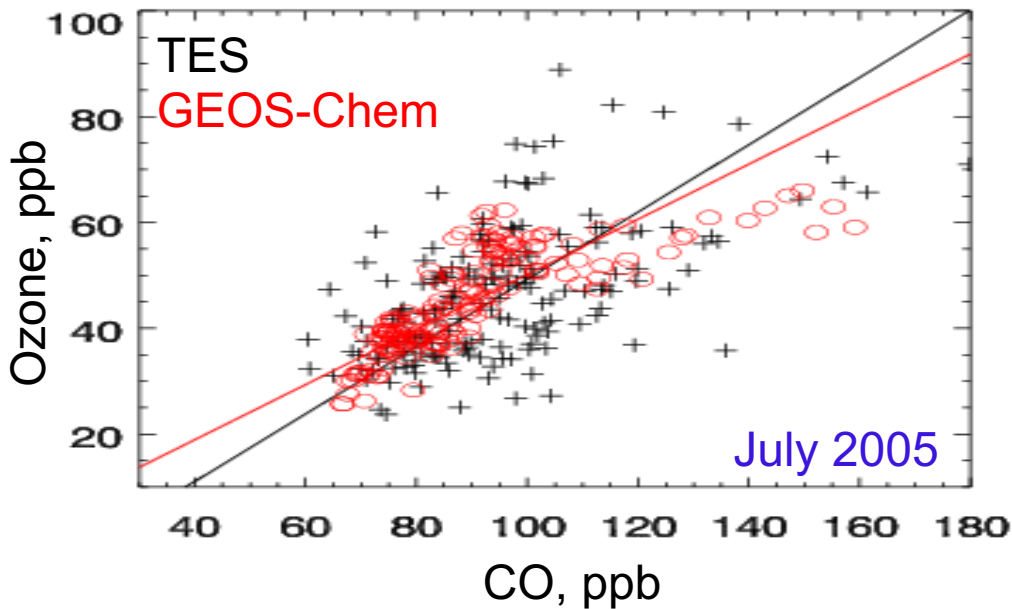
TES: first direct retrievals for global tropospheric ozone

shows mid-latitude pollution belt and global influence from tropical fires, tests global models

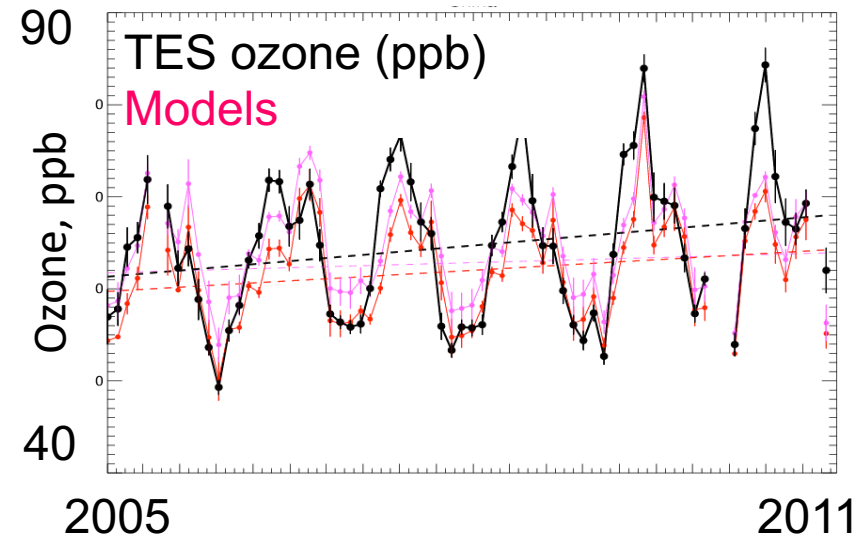


Increasing Chinese influence on tropospheric ozone seen by TES

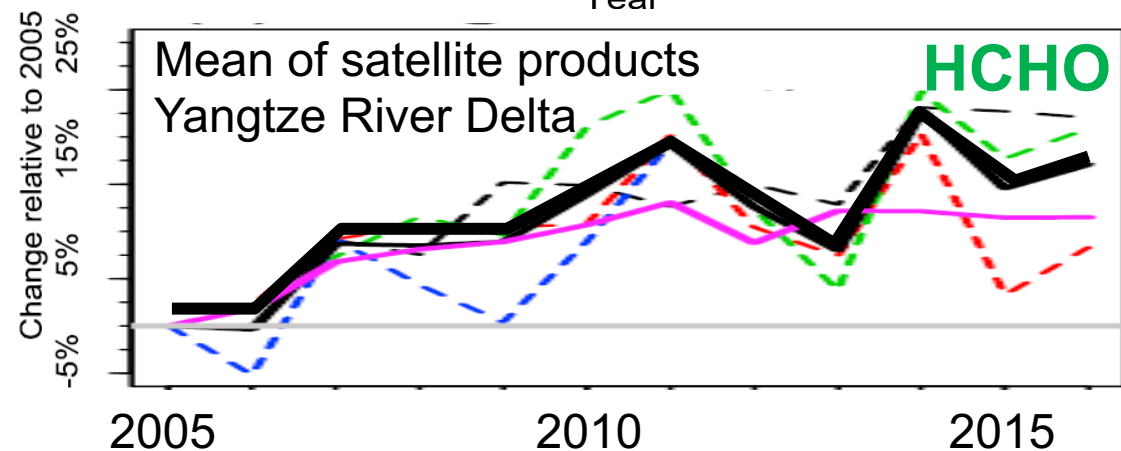
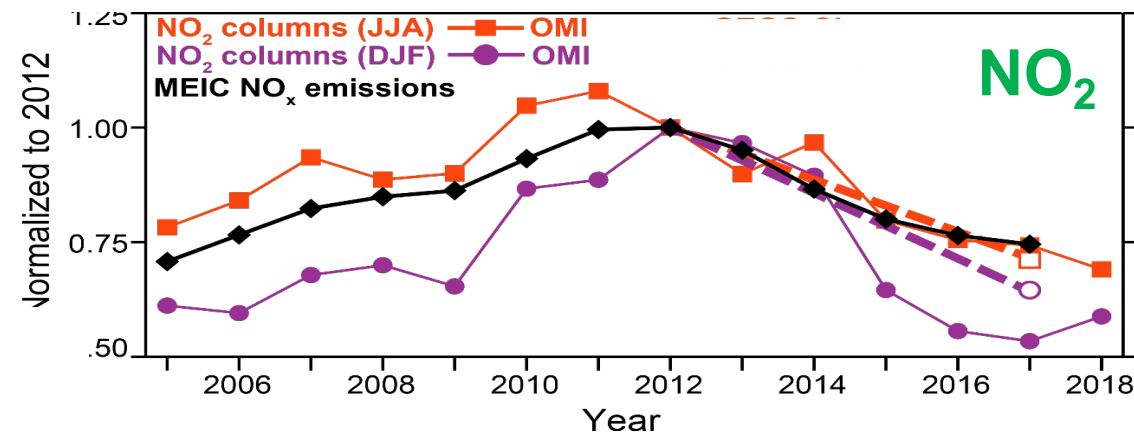
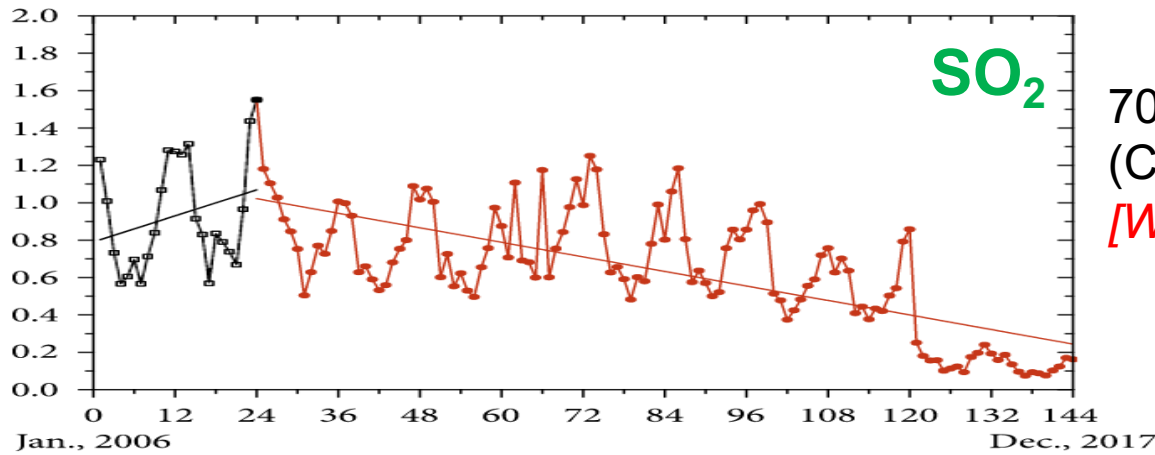
Ozone-CO relationship offshore of E Asia



2005-2011 ozone trend over China



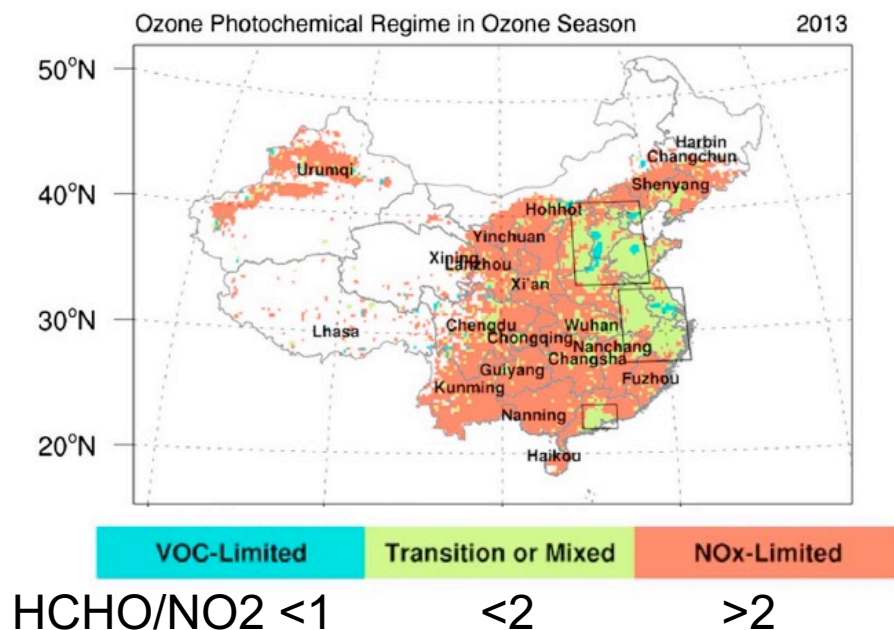
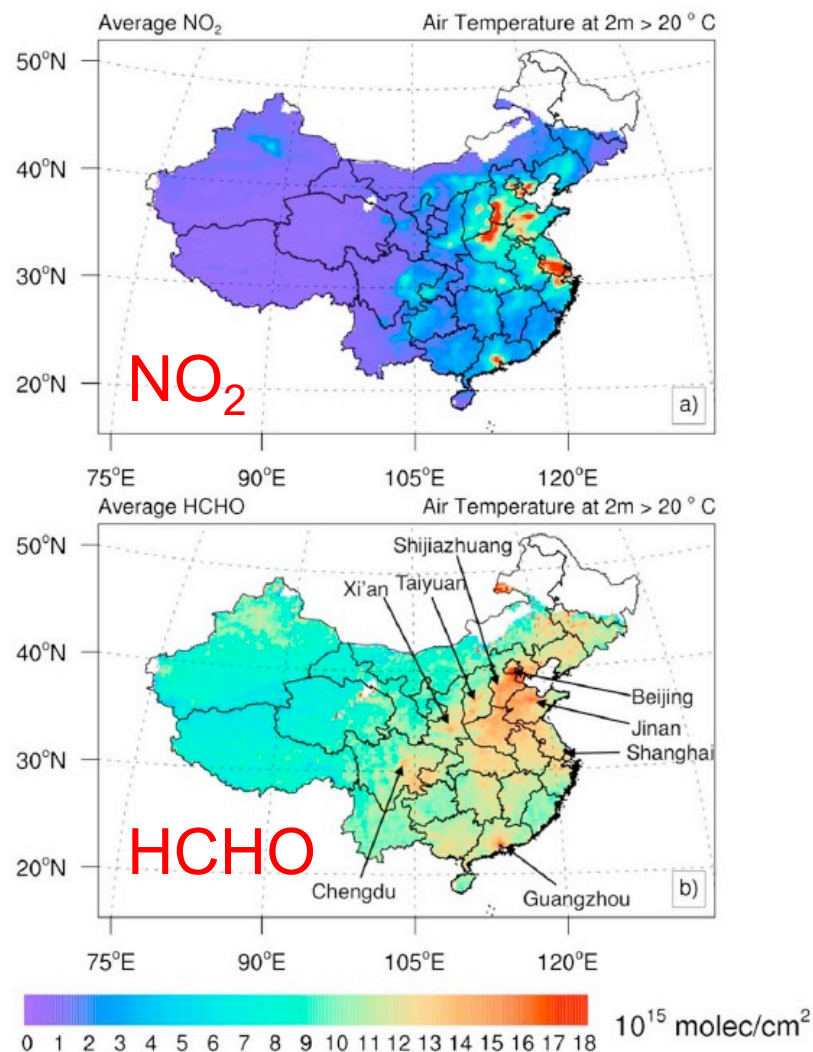
Reversal of Chinese emission trends observed by OMI



Using OMI HCHO/NO₂ ratios to diagnose ozone production regime

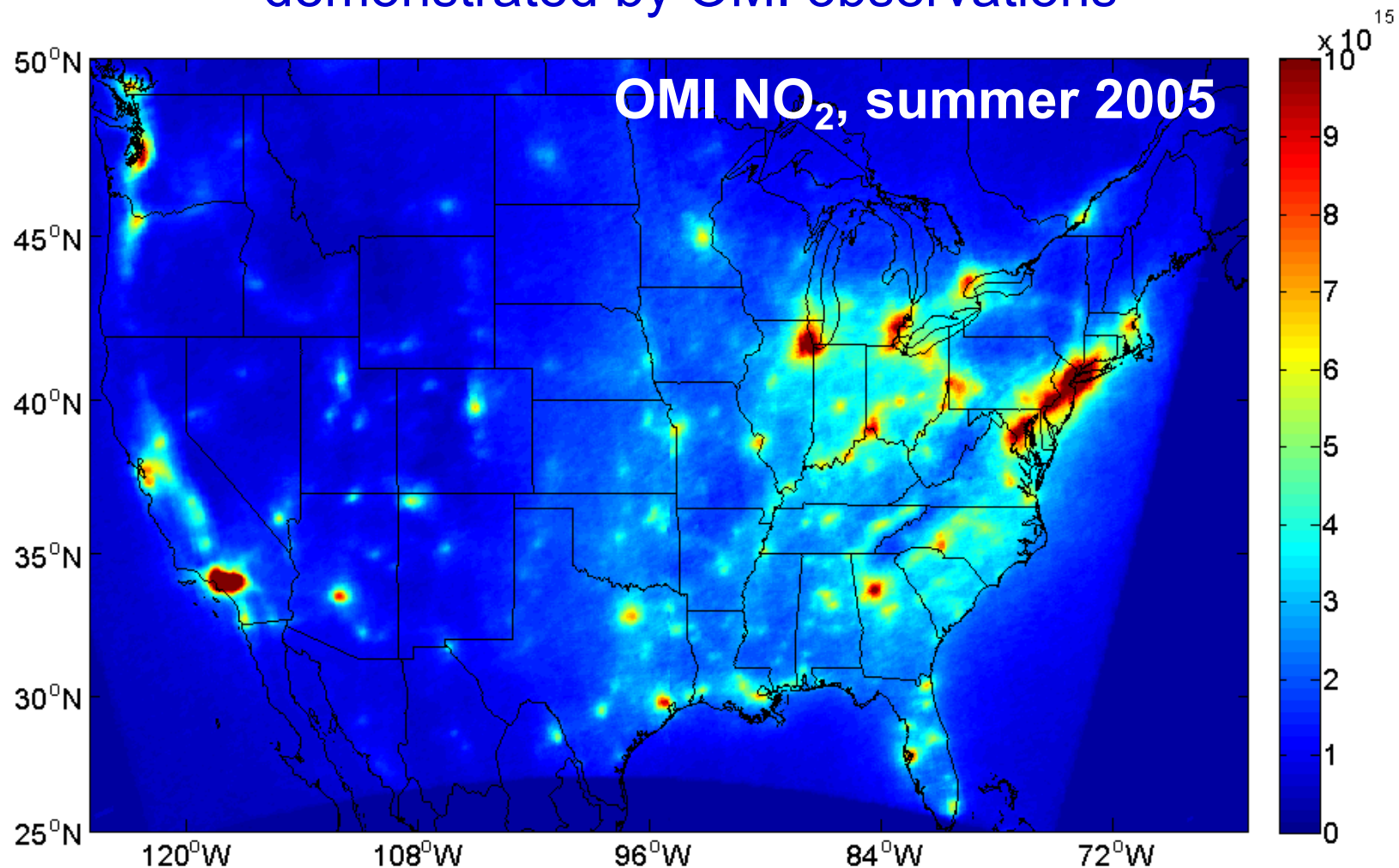
Ozone production can be limited by either NO_x or VOCs

2005-2013 OMI data

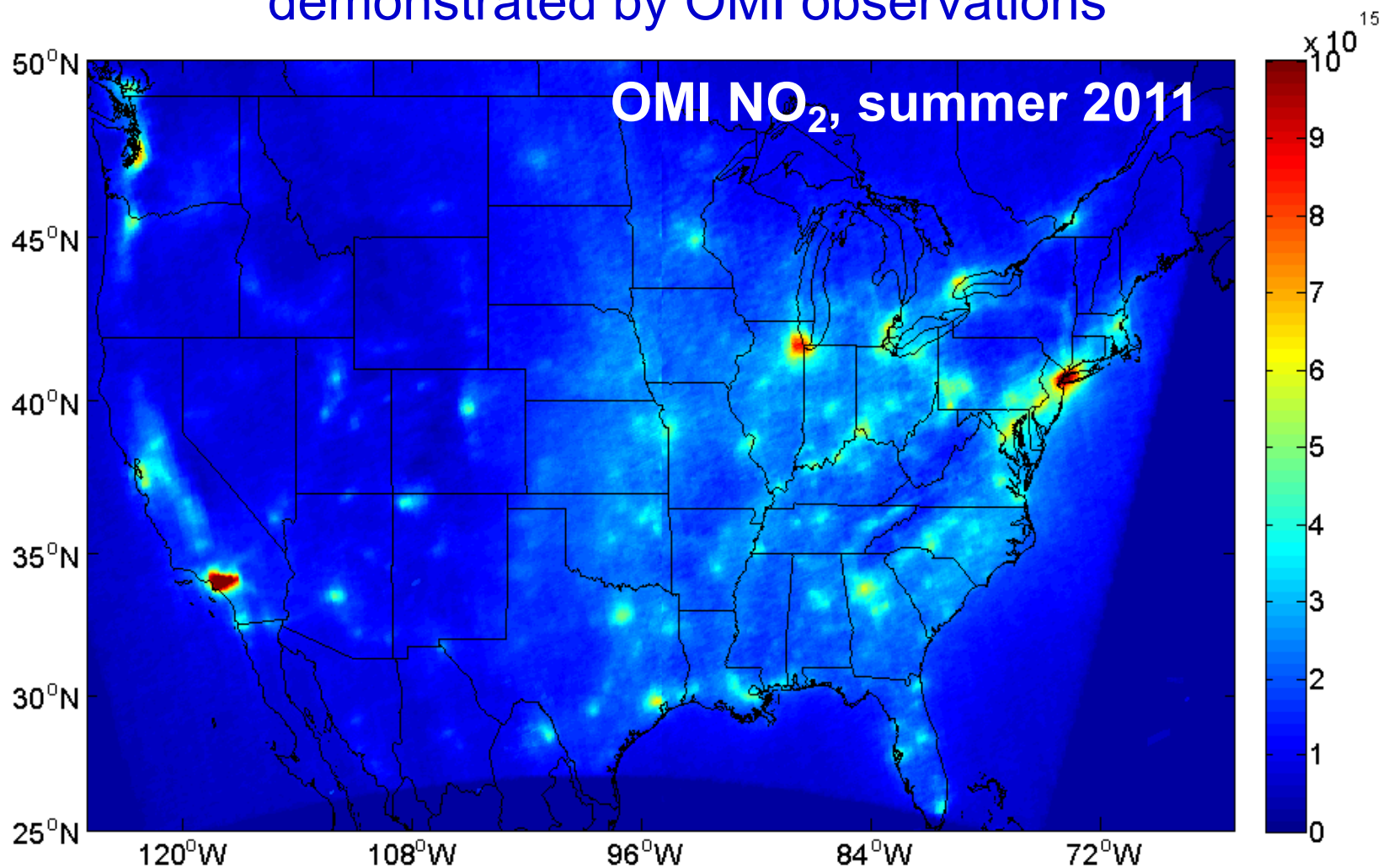


Ozone production in urban areas tends to be VOC-limited and VOC emissions have not been decreasing.

2005-2011 decrease of US NO_x emissions demonstrated by OMI observations



2005-2011 decrease of US NO_x emissions demonstrated by OMI observations



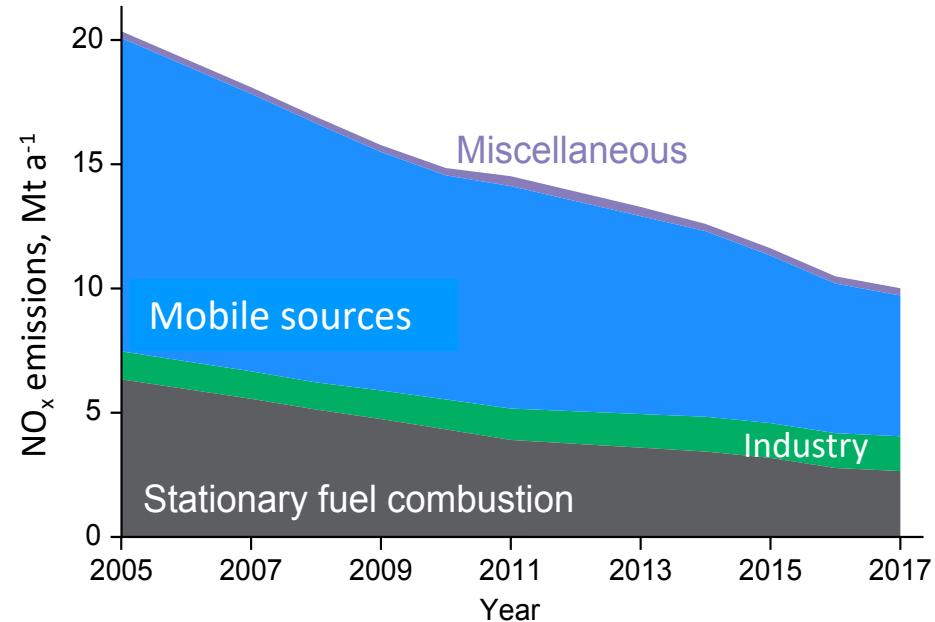
30% decrease in tropospheric NO_2 from 2005 to 2011,
consistent with EPA-reported NO_x emission trends

Russell et al. [2012]

US NO_x emissions have continued to decrease since 2011 according to EPA...
but OMI tropospheric NO₂ column observations suggest otherwise!

EPA National Emission Inventory (NEI):
53% sustained decrease of NO_x emissions
over 2005-2017

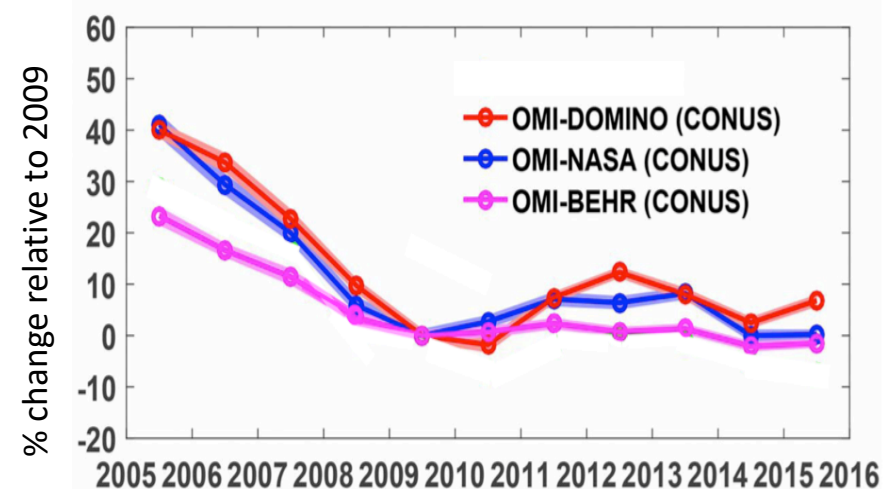
EPA, 2018



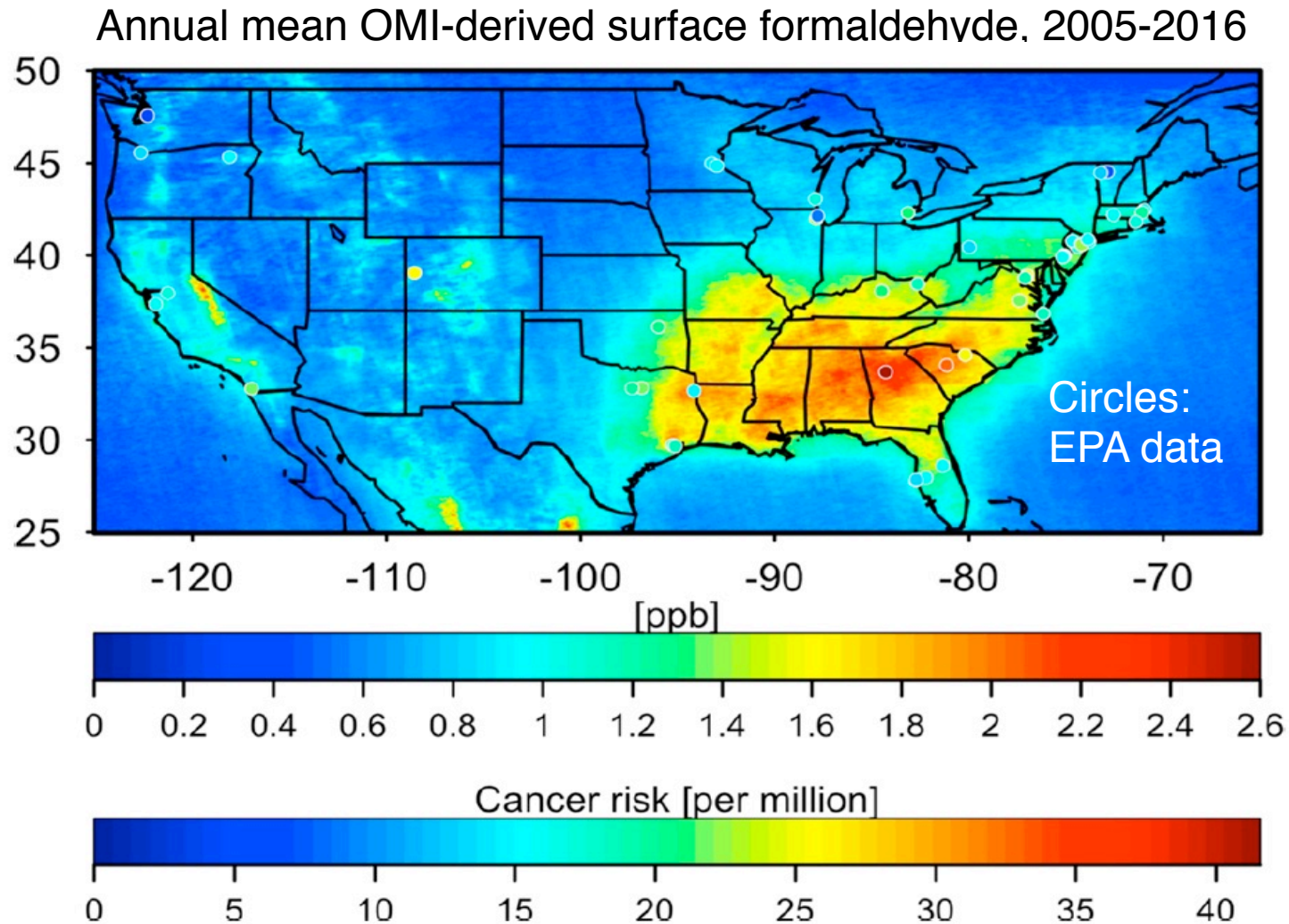
OMI NO₂ columns over CONUS, 2005-2016:
flat after 2011

Jiang et al., 2018

What's going on? Stay tuned for
Rachel Silvern, this afternoon



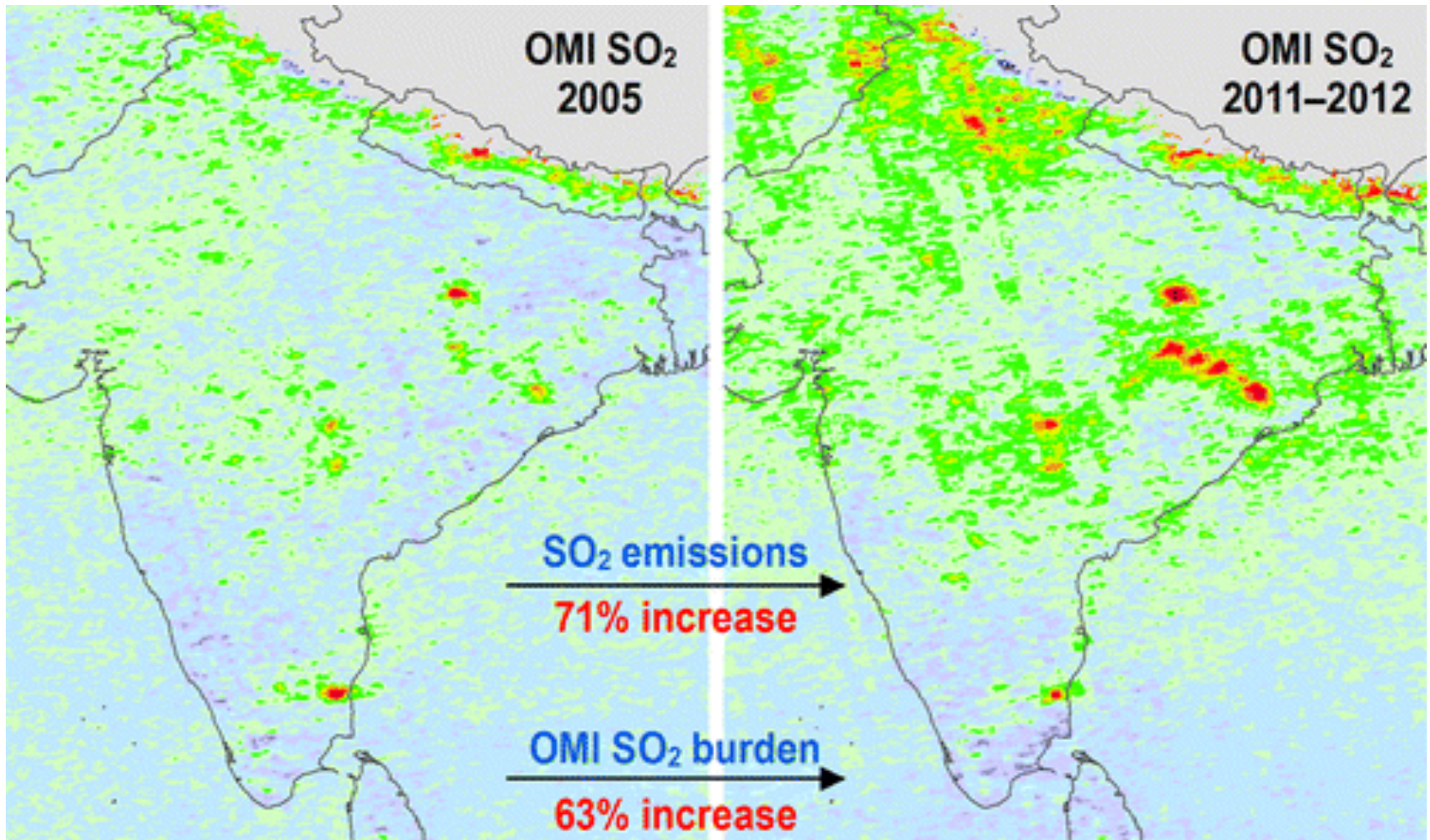
Formaldehyde over US demonstrates abundance of biogenic VOCs... ...and a significant cancer risk



6000-12000 people in US to develop cancer over their lifetimes from HCHO exposure

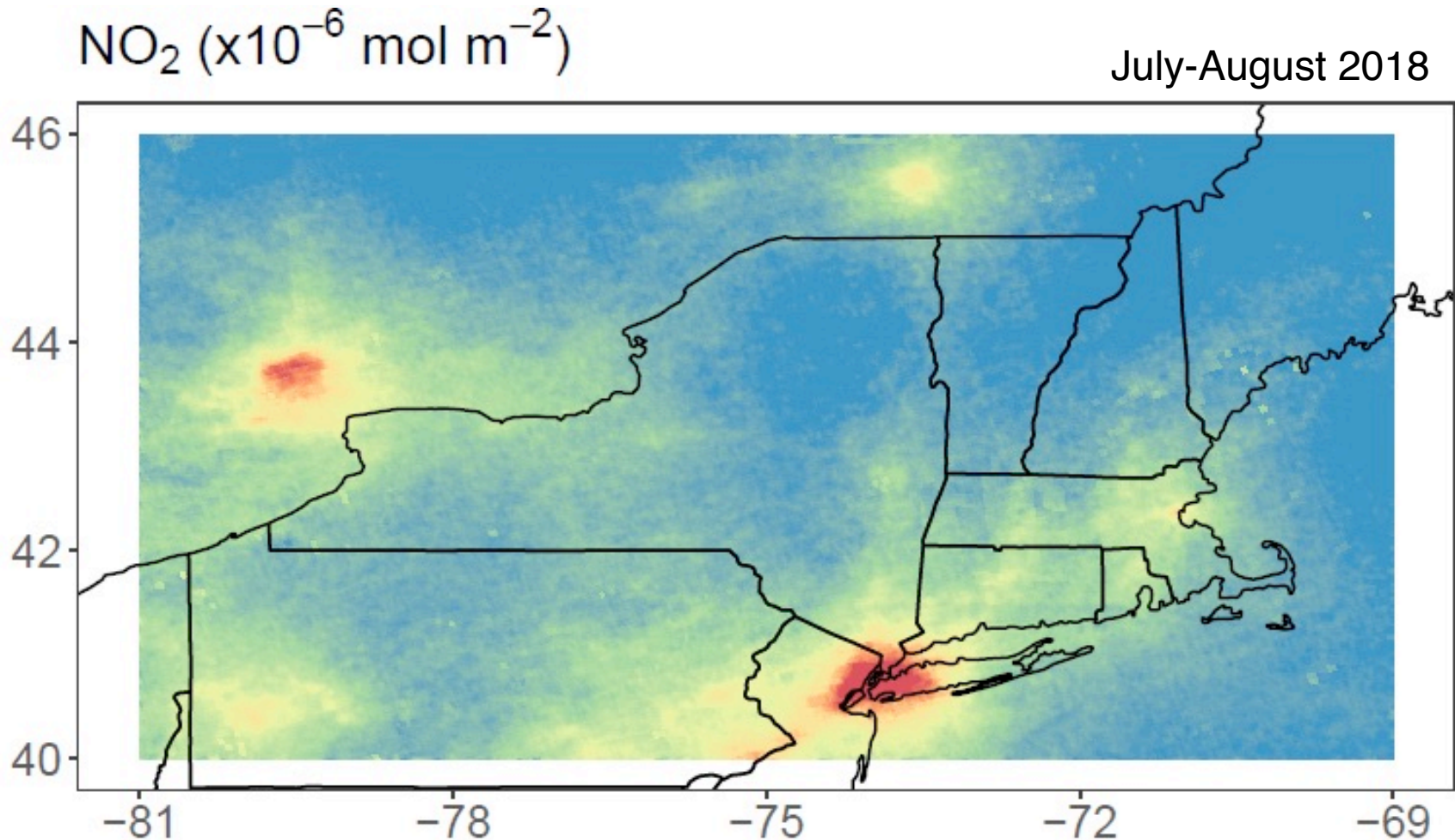
New air pollution frontier: India

OMI reveals rapid growth in SO₂ emissions from coal use



TROPOMI instrument launched in October 2017:

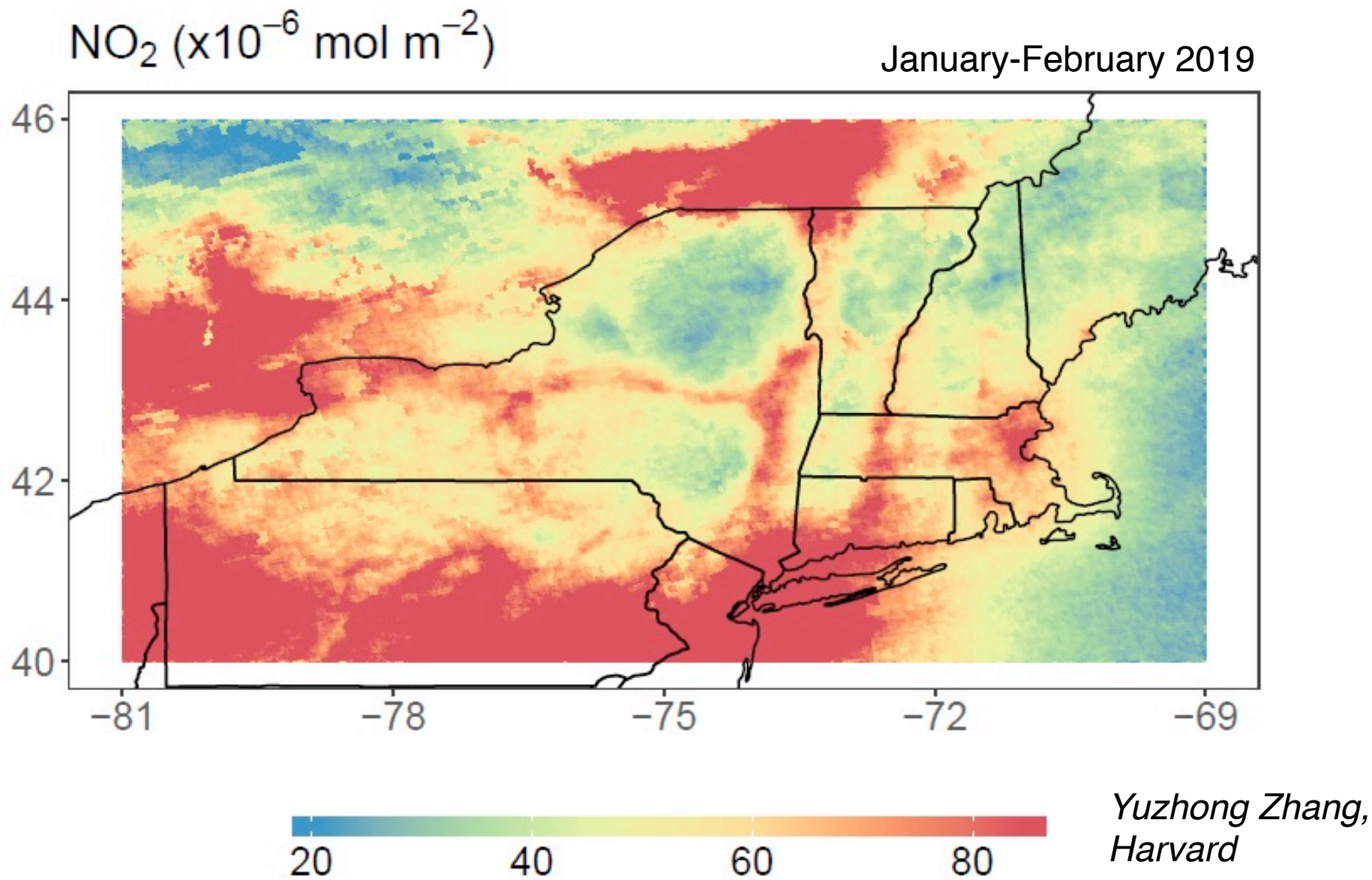
Global daily mapping of NO₂, formaldehyde, ozone, SO₂, CO, methane for 3.5x7 km² nadir pixels



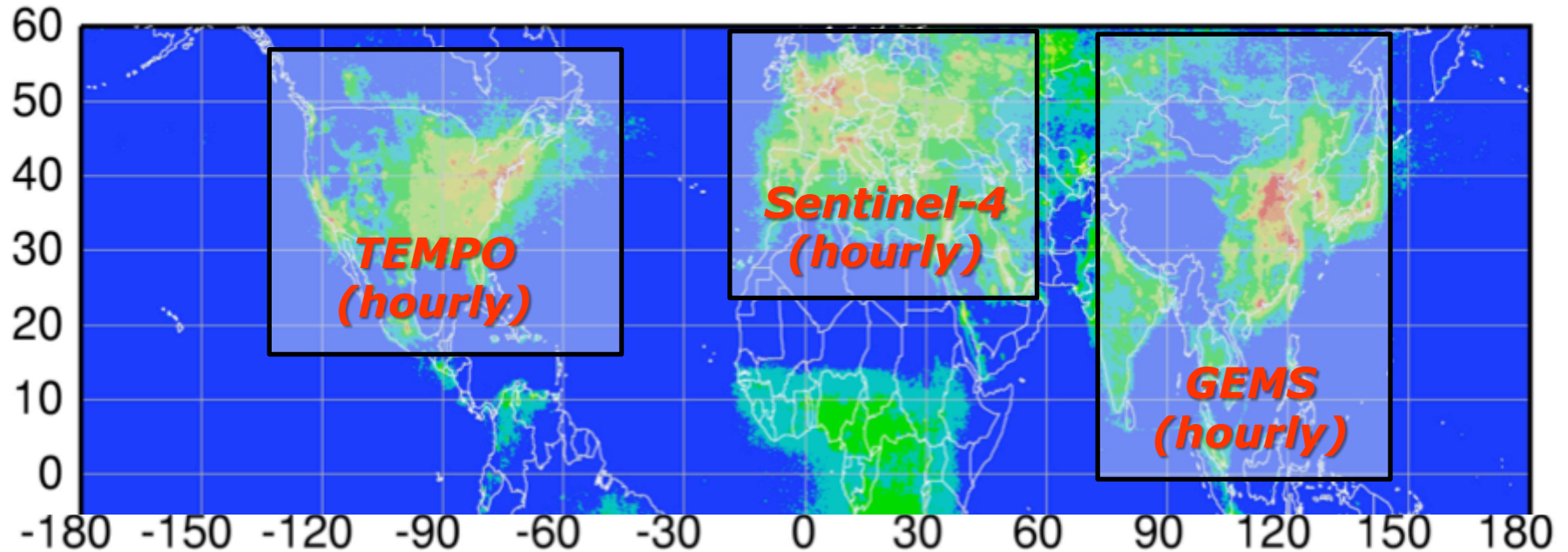
Yuzhong Zhang,
Harvard

TROPOMI instrument launched in October 2017:

Global daily mapping of NO₂, formaldehyde, ozone, SO₂, CO, methane
for 3.5x7 km² or 7x7 km² nadir pixels



Geostationary constellation for air quality (2020-2022 launches)

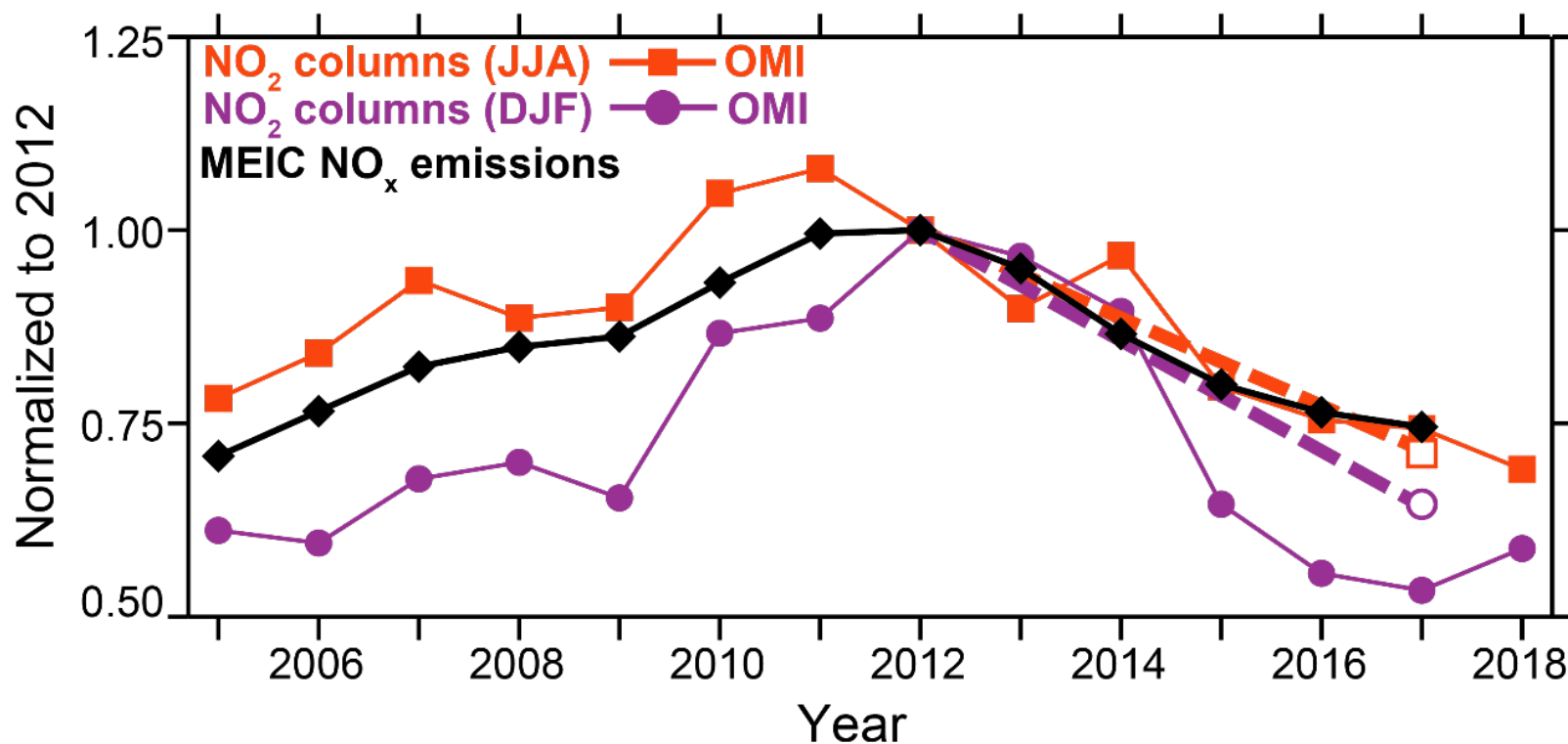


- **KARI GEMS:** Feb-Mar 2020 launch
 - 300-500 nm spectral range
 - 3.5x8 km² pixels
- **NASA TEMPO:** 2022 launch
 - 290-490 + 540-740 nm (for boundary layer ozone and SIF)
 - 2x5 km² pixels
- **ESA Sentinel-4:** 2021 launch
 - 315-500 + 750-775 nm
 - 8x8 km² pixels

OMI observed post-2012 reversal of NO_x emission trend in China

Governmental Clean Air Action initiated strong emission controls starting in 2013

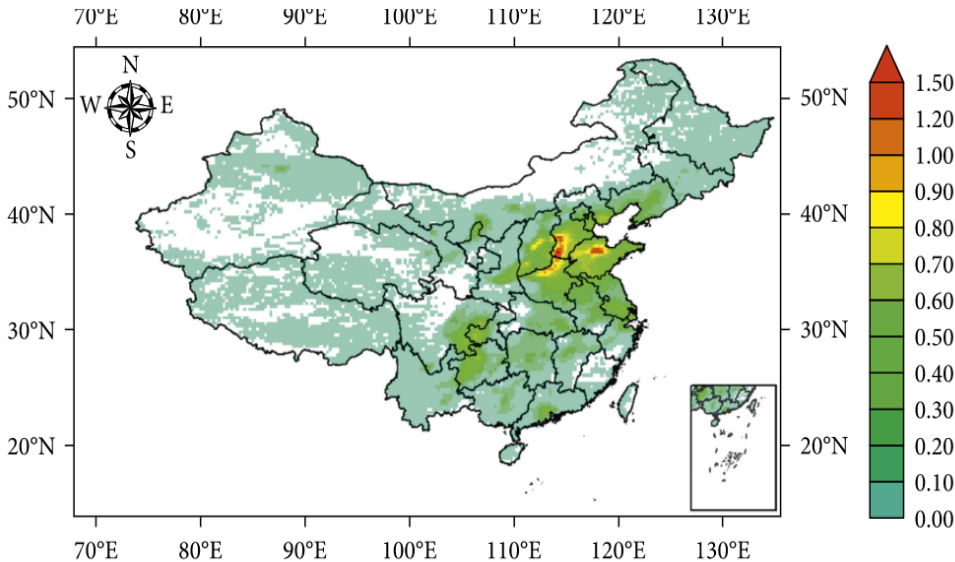
NO_x trends over China



- Confirms trends in MEIC bottom-up Chinese inventory
- Steeper OMI NO₂ trends in winter can be attributed to chemical feedbacks
[presentation by Viral Shah this afternoon]

OMI observes dramatic turnaround of Chinese SO₂ emissions

Mean OMI SO₂ over China, 2006-2017



70% decrease of SO₂ emissions over 2013-2017 period of Clean Air Action

OMI trend over Beijing region, 2006-2017

